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TECHNICAL REPORT

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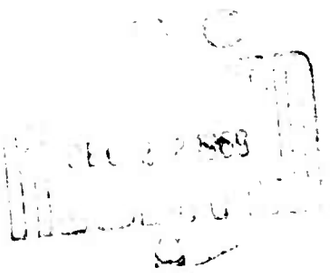
REPORT 1019

BULLET-IN-BORE STUDY OF 5.56MM, BALL, M193 CARTRIDGE AND M16A1 RIFLE

BY

FRANK E. BRAUN, JR.
AND
ROMAN FEDYNA



October 1969

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DEPARTMENT OF THE ARMY
FRANKFORD ARSENAL
PHILADELPHIA PA., 19137

61

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OF
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Ammunition Development and Engineering Laboratories
FRANKFORD ARSENAL
Philadelphia, Pa. 19137

October 1969

ABSTRACT

This test consisted of the firing of cartridges crimped to 100-pound average bullet pull (normal representative production value), 35-pound average bullet pull (minimum specification requirement) and uncrimped cartridges, all reassembled without propellant from each of two 5.56mm, ball, M193 cartridge lots (LC 12507 and TW 18310), in each of three M16A1 rifles with varying records of rounds fired.

The tests indicated that:

a. 5.56mm, ball, M193 cartridges without propellant, when fired, can lodge bullets sufficiently into the rifling of an M16A1 barrel to permit the chambering of the next round when the rifling of the barrel at the bullet seat is sufficiently worn or eroded.

b. Incidents of bullet-in-bore type malfunctions increase as the strength of the crimp is reduced.

c. The distance which a 5.56mm, ball, M193 bullet travels, from the energy exerted by primer action alone, varies with the type of primer. The metallic fueled Number 41 type primer will impart more energy than the nonmetallic fueled Number 195 primer.

PURPOSE

To investigate possible causative factors and describe effects of bullet-in-bore type malfunctions when firing 5.56mm, ball, M193 cartridges in M16A1 rifles.

TABLE OF CONTENTS

	Page(s
Introduction	1
Description of Tests	2
Material	2
Preparation for Tests	2
Firing of Tests	3
Discussion	4
Conclusions	8
Recommendations	9
List of Illustrations:	
Figure 1 -Chamber Casts of Weapons	10
Figure 2 -Chamber Casts of Damaged Fort Huachuca Rifle	11
Figure 3 -Recovered Bullet Jacket	12
Figure 4 -M16A1 (Fort Huachuca Rifle) Barrel Drawing	13
Figure 5 -Photograph of New Rifle (Serial No. 1326633)	14
Figure 6 -Photograph of New Rifle (Serial No. 1326633)	15
Figures 7 thru 20 -Photographs of Damaged Fort Huachuca Rifle (Serial No. 598656)	16 thru 29
Figures 21 thru 26 -Photographs of Damaged Cartridges and Related Parts	30 thru 35
Appendices:	
A -Final Coordinated Test Program	36
B -Ammunition Acceptance Reports	41
C -Bullet Pull Values of Cartridges as Received	43
D -Bullet Pull Values of Recrimped Cartridges	44
E -Bore Gage Measurements Before Firing	46
F -Summary of Test Results (Fort Huachuca Rifle)	51
G -Summary of Test Results (10,000 Round Rifle)	52
H -Summary of Test Results (New Rifle)	53
I -Bore Gage Measurements of Damaged Fort Huachuca Rifle	54
Distribution:	56
List of Tables:	
I -Number of "Modified" Cartridges Fired During the Test	3
II -Number of Bullets Lodged in the Bore	5
III -Average Bullet Position in the Bore	5

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INTRODUCTION

During April 1969 a team representing AMCPM-RS, USAWECOM, and USAMUCOM was deployed to three Army RVN training installations, viz, Fort Huachuca, Arizona, Fort Hood, Texas, and Fort McClellan, Alabama, to investigate recent M16A1 weapon system malfunctions which caused the destruction of several rifles. It had been determined that these M16A1 rifles being used at the above three installations were "damaged" due to the firing of a cartridge after the lodging of a bullet in the bore. In order to simulate the malfunctions observed and reported at the training installations and determine possible cause or causes, the following conditions were investigated in this test:

a. Tampered cartridges (propellant removed and bullet re-inserted without crimp).

(1) Effect of variance in primer type.

(2) Effect of variance in barrel condition.

b. Cartridges assembled without propellant with varying degrees of bullet crimp.

(1) Effect of variance in primer type.

(2) Effect of variance in crimp strength.

(3) Effect of variance in barrel condition.

The Project Manager, Rifles, USAWECOM, Rock Island, Illinois, formulated a test program which was forwarded to Frankford Arsenal for consideration, modification, and implementation. The final coordinated test program is attached as Appendix A.

DESCRIPTION OF TESTS

Material

Ammunition: Two 5.56mm, ball, M193 cartridge lots were used throughout the test. One lot (LC 12507) contained Number 41 type primers, and the other lot (TW 18310) contained Federal Number 195 type primers. Ammunition acceptance reports for both lots are attached as Appendix B.

Weapons: Three M16A1 rifles were used throughout the test; the first rifle was new, the second rifle had a record of approximately 10,000 rounds fired through its barrel, and the third rifle was obtained from Fort Huachuca, with a barrel history of more than 30,000 rounds fired.

Preparation for Tests

Ammunition: A 20-round sample from each ammunition lot as received, was subjected to a bullet pull test in accordance with AMSMU-P 715-501FA1. Results are attached as Appendix C. This test was conducted to determine the degree of bullet crimp which could be considered typical for a production lot of M193 cartridges (100 pounds).

A quantity of bullets from each ammunition lot was inertia pulled. The propellant was scrapped; the bullets and primed cartridge cases were then reassembled without propellant, and crimped so that 80 rounds from each lot provided a bullet pull of 35-pound average, and 80 rounds from each lot provided a bullet pull of 100-pound average. From these samples, 20 rounds from each lot and for each bullet pull value were tested. The values obtained from bullet pull tests in accordance with AMSMU-P 715-501FA1 are recorded in Appendix D.

To simulate tampering, a quantity of 20 rounds from each ammunition lot was debulleted by pressing the points/ogives of the bullet on a hard surface until the bullets could be extracted by hand. The propellant was scrapped; the bullets and primed cartridge cases were then reassembled by hand without propellant, and were not crimped.

All cartridges were checked by a "Go/No-Go" gage for overall length prior to loading into magazines.

Weapons: The barrel of each M16A1 rifle used in the test program was subjected to bore-gage measurements, and a cast of each chamber was made. Results of the bore-gage measurements are recorded in Appendix E. Measurements of the chamber casts are shown in Figure 1.

Firing of Tests

All firing was conducted indoors at a Function and Casualty Range at ambient temperature ($70^{o} \pm 2^{o}$ F). One test fixture was used throughout the firing. The following table indicates the actual number of "modified" cartridges fired during the test.

Table I

Number of "Modified" Cartridges Fired During the Test

	100-pound Bullet Pull		35-pound Bullet Pull		Not Crimped	
M16A1 Rifle	LC12507	TW18310	LC12507	TW18310	LC12507	TW18310
Fort Huachuca (30,000 rds)	20	20	5	5	3*	5
Used (10,000 rds)	20	20	5	5	5	5
New	20	20	5	5	4*	5
TOTAL	60	60	15	15	12	15

* Failures-to-feed attributed to faulty magazines precluded firing five rounds.

Each of the modified rounds was positioned in a magazine so that it was the third round fired in automatic mode. The two preceding rounds in each magazine were "unmodified" cartridges from the same lot as the "modified" cartridge. The remaining 17 rounds in each magazine (which were not fired) were also "unmodified" cartridges from the same lot.

In all firing observations, the weapon stopped firing after the third round. After each stoppage, it was first determined whether the bullet of the "modified" cartridge had separated from the case. If the bullet did not separate from the case, the cartridge was rechecked to see whether the length increased beyond the normal maximum allowable assembled length. If the bullet did separate from the cartridge case, the position of the bullet in the bore was measured and recorded, and an attempt was made to chamber the following cartridge employing first the charging handle and then the forward assist. If the bolt remained in the unlocked position, the attempt to chamber a round was repeated for two additional rounds. The bullet was then removed from the bore and the testing continued by insertion of another loaded magazine.

After completion of the above testing in all three rifles, the rifle from Fort Huachuca was used in a destructive test wherein a modified noncrimped cartridge was fired and the bullet lodged in the bore. The next cartridge was chambered behind the lodged bullet and fired to determine the effects.

DISCUSSION

Weapons: Three M16A1 rifles exhibiting extreme bore erosion, but otherwise serviceable, were shipped from Fort Huachuca to Frankford Arsenal. The barrels of all three rifles were bore gaged, that is, measured for the diameters of the lands and grooves for the entire length of the bore. These bore-gage measurements served as the parameter in choosing the weapon to test for destruction. The rifle chosen, serial Number 598656, had a barrel history exceeding 30,000 rounds and showed most erosion at the origin of rifling. Results of the measurements of the three Fort Huachuca rifles are attached as Appendix E.

Ammunition: As stated previously, two 5.56mm, ball, M193 cartridge lots were used throughout this test: LC 12507 (Number 41 type primers) and TW 18310 (Federal Number 195 primers). The LC 12507 lot was accepted on 29 Oct 68, and the TW 18310 lot on 3 Apr 68.

Significant Observations in Nondestruction Tests (see Appendices F, G, and H)

a. Description of modified cartridge components after firing.

(1) The cartridge-case mouth and bullet base of all cartridges were coated with a black residue both inside and outside (typical of a cartridge fired without propellant).

(2) All bullets recovered from the bore were partially engraved by the rifling.

b. Frequency of bullet-in-bore type malfunctions (see Table II).

(1) LC 12507 (Number 41 type primer) modified cartridges with a 100-pound average bullet pull produced bullet-in-bore malfunctions at the rate of 1 in 3. TW 18310 (Federal Number 195 primer) modified cartridges produced bullet-in-bore malfunctions at the rate of 1 in 60.

(2) Modified cartridges with 35-pound average bullet pull and/or noncrimped cartridges from both lots LC 12507 and TW 18310, produced 100% bullet-in-bore malfunctions.

Table II

Number of Bullets Lodged in Bore

Ammunition	Rifle	Bullet Pull in Pounds		Not Crimped
		100	35	
LC 12507 (Number 41 Type Primer)	Fort Huachuca	6 of 20	5 of 5	3 of 3*
	10,000 rounds	5 of 20	5 of 5	5 of 5
	New	8 of 20	5 of 5	4 of 4*
TW 18310 (Federal Number 195 Primer)	Fort Huachuca	0 of 20	5 of 5	5 of 5
	10,000 rounds	1 of 20	5 of 5	5 of 5
	New	0 of 20	5 of 5	5 of 5

*Failure-to-feed malfunction attributed to magazine precluded firing 5 rounds.

c. Position of bullets-in-bore (see Table III).

(1) For all modified cartridges, the bullet lodged farthest down the bore from the chamber in the Fort Huachuca rifle and travelled the shortest distance from the chamber in the new rifle. The position of bullets-in-bore for any given weapon and for any related bullet pull was consistent (see Figure 4).

(2) For LC 12507 modified cartridges, the bullets lodged further down the bore from the chamber in all weapons than did any bullets of TW 18310 modified cartridges.

Table III

Average Bullet Position in Bore [i]

Ammunition	Rifle	Bullet Pull		Not Crimped
		100 pounds	35 pounds	
LC 12507 (Number 41 Type Primer)	Fort Huachuca	16.641	16.600	16.532
	10,000 rounds	17.075	17.062	17.137
	New	17.562	17.562	17.437
TW 18310 (Federal Number 195 Primer)	Fort Huachuca	---	16.725	16.725
	10,000 rounds	17.188	17.163	17.188
	New	---	17.562	17.574

[i] Values given represent distance from muzzle (without flash suppressor) to bullet point (see Figure 4).

d. Consequence of bullets lodged in bore.

(1) Fort Huachuca Rifle - the total number of bullets lodged in the bore was 23. All succeeding rounds could be chambered without resistance, that is, without indenting the base of the lodged bullet or without pushing the bullet of the chambered round into its cartridge case.

(2) 10,000 Round Rifle -the total number of bullets lodged in the bore was 26. Only three succeeding rounds could be chambered without resistance. An additional seven succeeding rounds could be chambered, but force was required to overcome resistance (see Figure 25). No succeeding rounds could be chambered behind the other 16 instances of bullets lodged in bore due to excessive resistance (procedure described in Appendix A).

(3) New Rifle - the total number of bullets lodged in the bore was 27. With one exception (see Figure 26), no succeeding rounds could be chambered due to excessive resistance (procedure described in Appendix A).

Note. - In each of the three weapons, two attempts were made to chamber the succeeding round by releasing the charging handle; when this failed to accomplish complete chambering, the forward bolt assist also failed.

e. Cartridge Elongation.

Where modified cartridges failed to produce bullet-in-bore type malfunctions, chambered cartridges elongated as much as .012" beyond the maximum allowable cartridge length due to pressure from the primer (see Figure 24). Exact original lengths of cartridges were not determined although the lengths after hand crimping were gaged for acceptability with a "Go/No-Go" gage.

Significant Observations in Special Weapon Destruction Test

a. A noncrimped cartridge (modified to simulate tampering) from lot LC 12507 was fired. The bullet lodged in the bore at a position far enough forward of the rifle chamber so that the succeeding cartridge could be chambered in the normal manner without indenting the base of the bullet in the bore. This is typical of the results of previous tests with the Fort Huachuca Rifle. The actual clearance between the base of the lodged bullet and the point of the bullet of the chambered cartridge was approximately .406 inch.

b. With the bullet in the bore and upon chambering an unmodified LC 12507 cartridge and firing, the weapon was badly damaged around the upper receiver (splitup to and along the carrying handle) and magazine areas (see Figures 7 through 20). The disassembly of the weapon revealed a bulged magazine housing (see Figure 12), a damaged magazine with three damaged cartridges

which were blown from the magazine and found on the floor of the gun-mounting fixture (see Figure 13), a fractured bolt carrier (see Figure 18), a bent and broken extractor (see Figure 17), a crack in the wall of the barrel through the locking lugs (see Figure 20), a ruptured cartridge case[i] which was lodged in the chamber, and a bullet jacket[ii] found in the bullet seat when removing the ruptured cartridge case. The recovered bullet jacket weighed 13.557 grains. The nominal weight of a normal bullet jacket is 17.000 grains.

[i] The ruptured cartridge case was that of the succeeding cartridge that was chambered completely and fired into the lodged bullet in the bore (see Figures 20 and 21).

[ii] It is theorized that this bullet jacket was from the lodged bullet in the bore. Upon examination, it was observed that the wall of the bullet jacket and cannelure were "ironed out" against the bore of the rifle by virtue of the passage of the second bullet through the bullet lodged in the bore (see Figures 3 and 22).

c. The barrel was then subjected to additional examination as follows:

(1) Upon visual inspection of the barrel, a carbon ring deposit was observed in the throat area. A borescope examination determined the location of the deposit to be between 16.65 and 16.80 inches from the muzzle (without flash suppressor).

(2) The barrel of the weapon was then defouled with a standard metal defouling solution and cleaned thoroughly. The land and groove diameters were measured in 1-inch increments (at each of three radial positions) up to the approximate location where the carbon ring deposit was previously observed (16.00 inches). At the 16.00-inch location, groove diameter readings at 0.1-inch increments were taken (at each of three radial positions). These measurements revealed a slight ring bulge in the throat area where the bullet jacket was lodged and where the carbon deposit appeared to be previously (see Appendix I).

(3) A chamber cast of the damaged Fort Huachuca Rifle was also made(refer to Figure 2).

Note. - The three radial positions are identified as follows:

a. At the reference point (0^{o}), that is, positioning the gas port of the barrel vertically upwards.

b. 120^{o} from the reference point.

c. 240^{o} from the reference point.

CONCLUSIONS

1. As related to primer type and degree of bullet crimp:

a. Upon firing M193 cartridges without propellant, the Number 41 type primer is more likely to lodge a bullet in the bore of an M16/M16A1 rifle than is the Federal Number 195 primer regardless of degree of bullet crimp.

b. Upon firing M193 cartridges without propellant, the Number 41 type primer is also more likely to impart greater travel to a bullet lodging in the bore of an M16/M16A1 rifle regardless of condition of rifle bore.

c. Upon firing M193 cartridges without propellant, both types of primers produced bullets in the bore, on all occasions of testing, when the bullet crimp ranged from "no crimp" (tampered cartridges) to 35-pound average bullet pull (minimum specification requirement). However, at a bullet pull of 100-pound average, on all occasions of testing, the Number 41 type primer produced significantly more bullets lodged in the bore than did the Federal Number 195 primers.

2. As related to conditions of the rifle bore:

a. The degree of bullet travel and the ability to chamber cartridges behind a lodged bullet-in-bore, are both dependent upon the condition of the origin of rifling, that is, the severity of erosion.

b. In the Fort Huachuca Rifle, characterized by severe bore erosion at the origin of rifling, all occurrences of "bullet lodged in the bore" were accompanied by sufficient bullet travel to permit the chambering of succeeding cartridges without application of force or without distortion to the chambered cartridge.

c. In the used rifle (10,000 rounds fired) characterized by moderate bore erosion at the origin of rifling, succeeding cartridges on most occasions (10 out of 15) could be chambered behind those bullets lodged in the bore by the Number 41 type primer. In some instances this was accomplished with force, and in others without force, depending upon degree of bullet travel. However, bullet-in-bore associated with the Federal Number 195 primers did not produce sufficient bullet travel to permit chambering of a succeeding cartridge on any occasion, regardless of the amount of force applied.

d. In the new rifle (no previous rounds fired) characterized by no bore erosion at the origin of rifling, succeeding cartridges could not be chambered behind a "bullet lodged in bore" regardless of the primer type involved or amount of force applied, except on one unique occasion. On this occasion a Number 41 type primer afforded sufficient bullet travel to allow complete chambering of a succeeding cartridge, but only after the application of force causing sufficient cartridge distortion to permit locking of the rifle bolt.

3. Severe weapon damage will result when a normally loaded cartridge is chambered and fired behind a bullet lodged in the bore of an M16/M16A1 rifle.

4. All tampered cartridges (cartridges without propellant and without bullet crimp) when chambered and fired in the M16/M16A1 rifle will cause bullets to be lodged in the bore independent and regardless of any other factor.

5. Likewise, when chambering and firing cartridges assembled without propellant and crimped in the range of normal production cartridges (from 35 to 100-pound average), bullets can also be lodged in the bore of M16/M16A1 rifles.

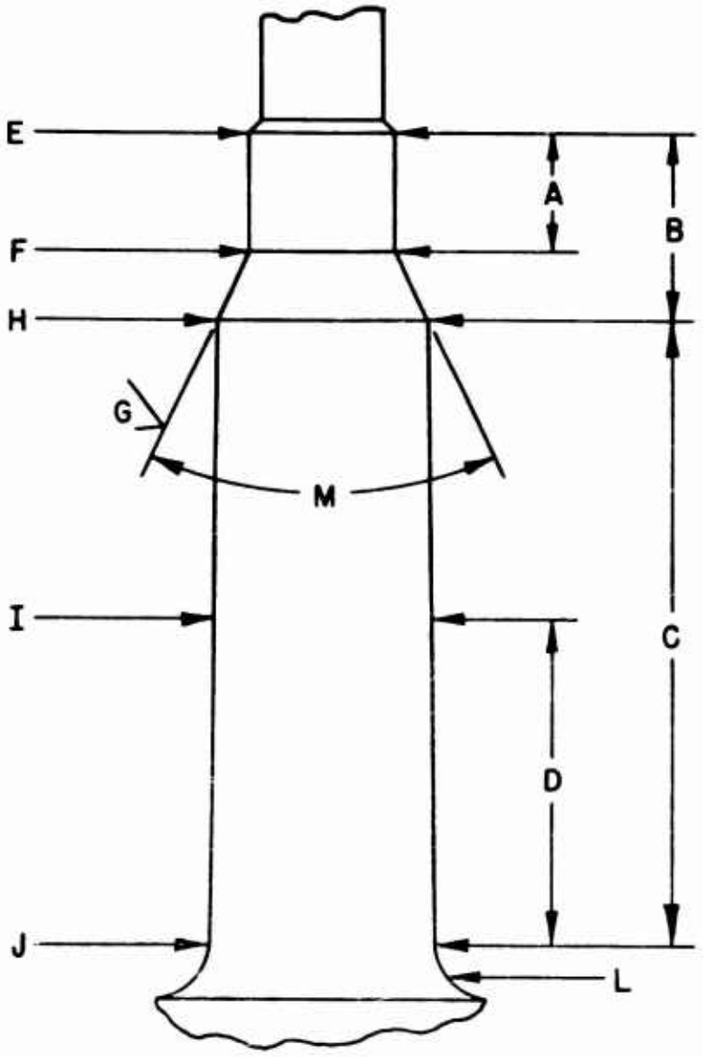
Note.- a. The minimum bullet pull requirement of 35-pound average is a practical and realistic limit commensurate with normal mass-production practices and variables for 5.56mm cartridges. It would be imprudent to consider a change to this requirement for any reason, presumably highlighted by this test program. It would be particularly imprudent to believe that an increase in the minimum bullet pull limit, or in the range for normal cartridge production would lead to a solution of the bullet-in-bore problem.

b. Although possible, the probability of cartridges inadvertently being produced without propellant, and passing undetected through inspection, weighing, packaging, and being shipped from an ammunition producer, is very remote because of the elaborate precautions taken to preclude this occurrence. Nevertheless, considering that literally billions of rounds of small arms ammunition are manufactured each year, it is not impossible that some cartridges without propellant have been produced. Consequently, improved safeguards are constantly being pursued to preclude even the most remote possibility of this occurrence.

RECOMMENDATIONS

Draft a document for distribution to the Using Services citing the causes, consequences, and recommended precautions and remedies for this type malfunction.

FIGURE 1

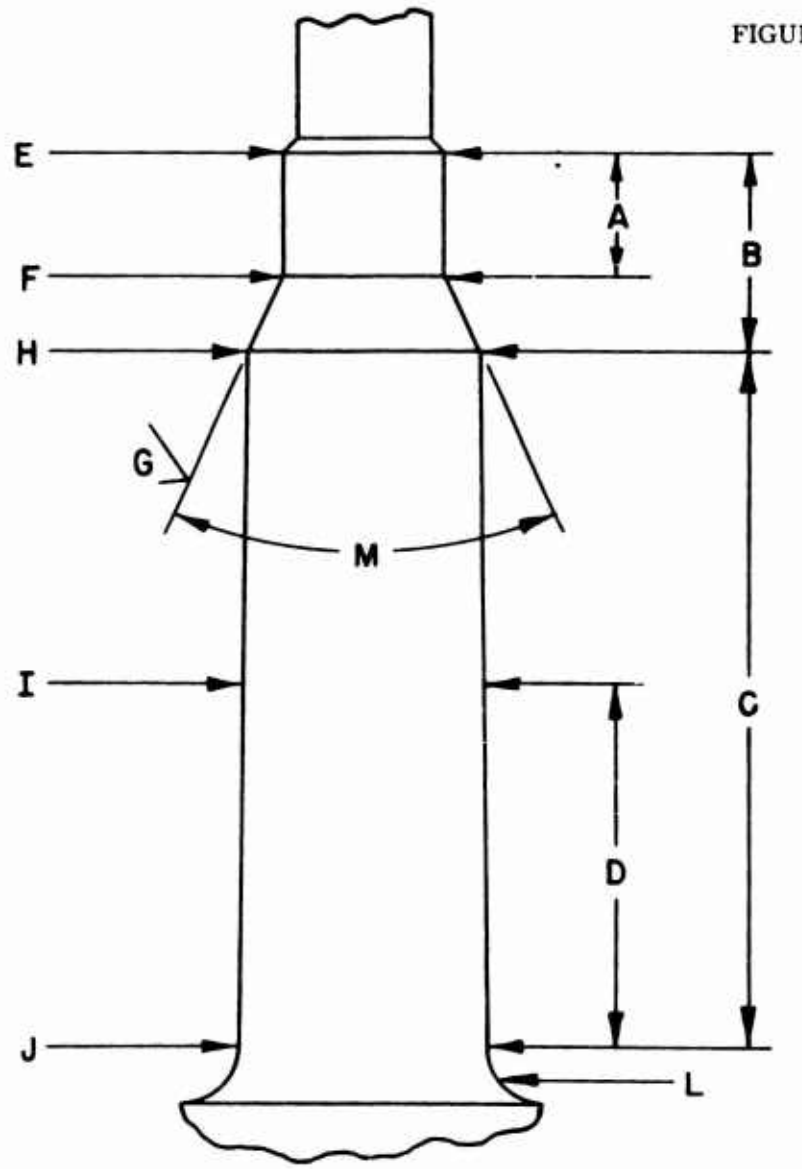


IDENTIFICATION

	HUACHUCA RIFLE	10,000 RD RIFLE	NEW RIFLE
A	.213	.213	.210
B	.343	.3415	.343
C	1.226	1.226	1.226
D	REF .500	REF .500	REF .500
E	.255	.255	.255
F	.258	.258	.258
G	16 APPROX	63 APPROX	63 APPROX
H	.3565	.3565	.3565
I	.370	.370	.370
J	.381	.381	.381
L	.060 RADIUS	.060 RADIUS	.060 RADIUS
M	46° INCL	47° INCL	46° INCL

CHAMBER CASTS OF WEAPONS

FIGURE 2

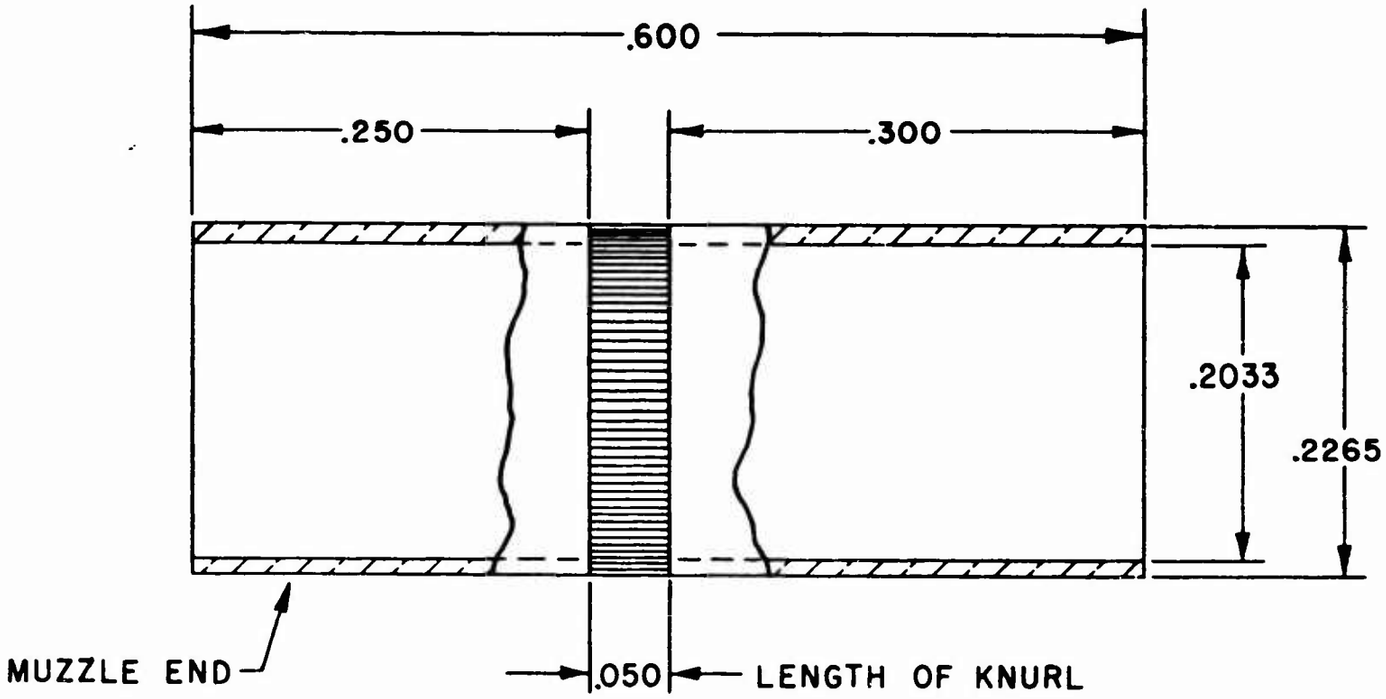


	DAMAGED HUACHUCA RIFLE
A	.2095
B	.345
C	1.226
D	REF .500
E	.255
F	.258
G	16/ APPROX
H	.357
I	.370
J	.382
L	.060 RADIUS
M	46° INCL

CHAMBER CAST OF DAMAGED HUACHUCA WEAPON

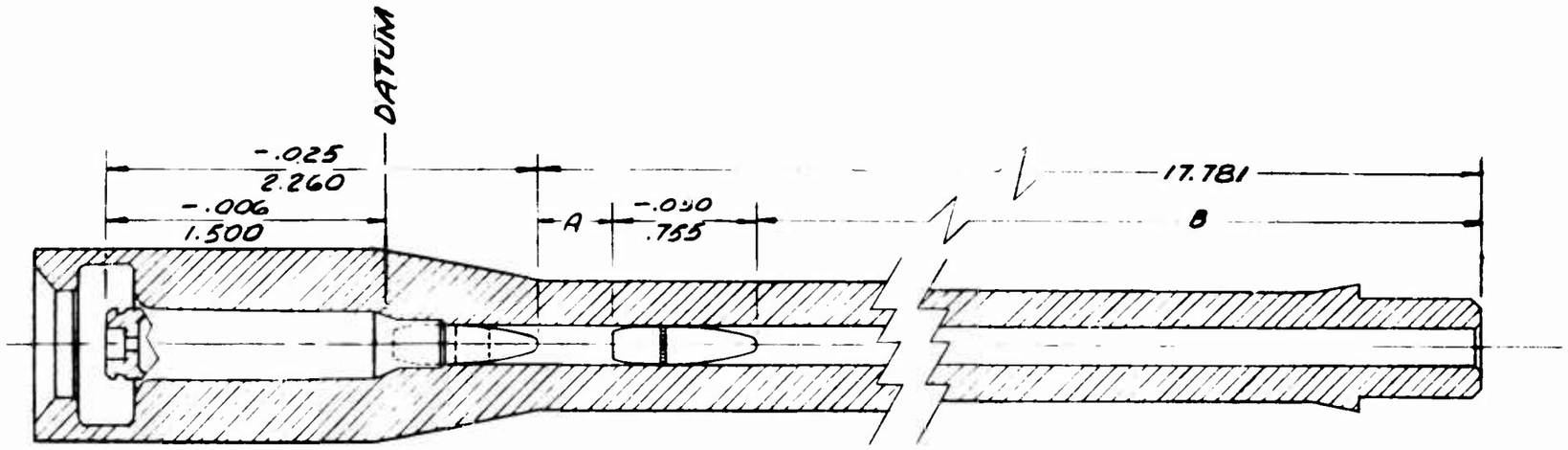
FIGURE 3

WEIGHT OF RECOVERED BULLET JACKET = 13.557 GRAINS



RECOVERED BULLET JACKET

Figure 4



	A		B	
	MIN	MAX	MIN	MAX
HUACHUCA RIFLE	.276	.589	16.437	16.750
10,000 RD. RIFLE	⊛	.026	17.000	17.187
NEW RIFLE	⊛	⊛	17.437	17.625

⊛ ZERO CLEARANCE - ROUND COULD NOT BE CHAMBERED BEHIND BULLET LODGED IN BORE WITHOUT FORCE, RESULTING IN EITHER INDENTING BASE OF LODGED BULLET OR PUSHING BULLET OF CHAMBERED CARTRIDGE INTO CARTRIDGE CASE OR BOTH.

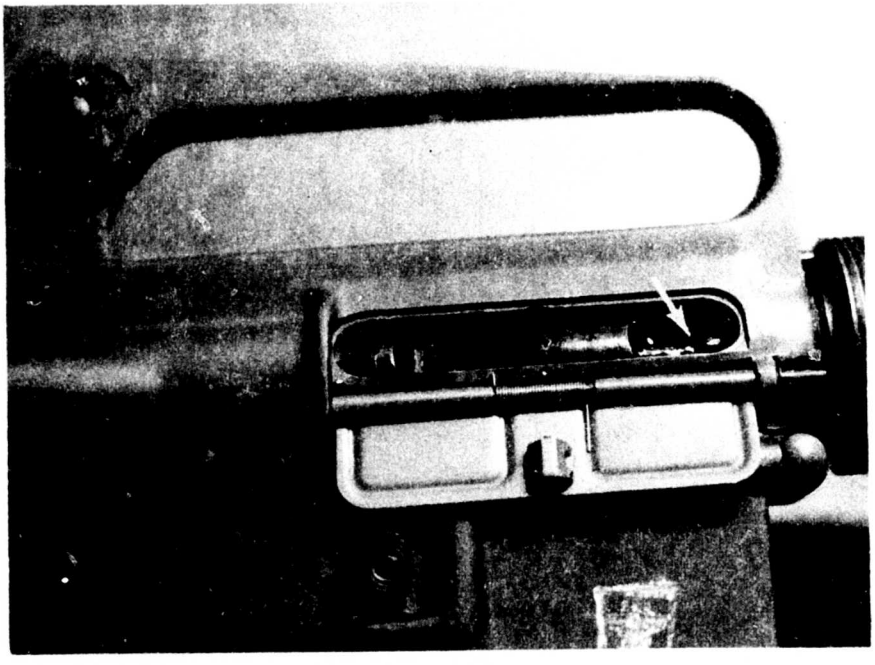


Figure 5. Side view of New Rifle (Serial No. 1326633) with a bullet lodged in the bore, preventing complete chambering of the succeeding round.

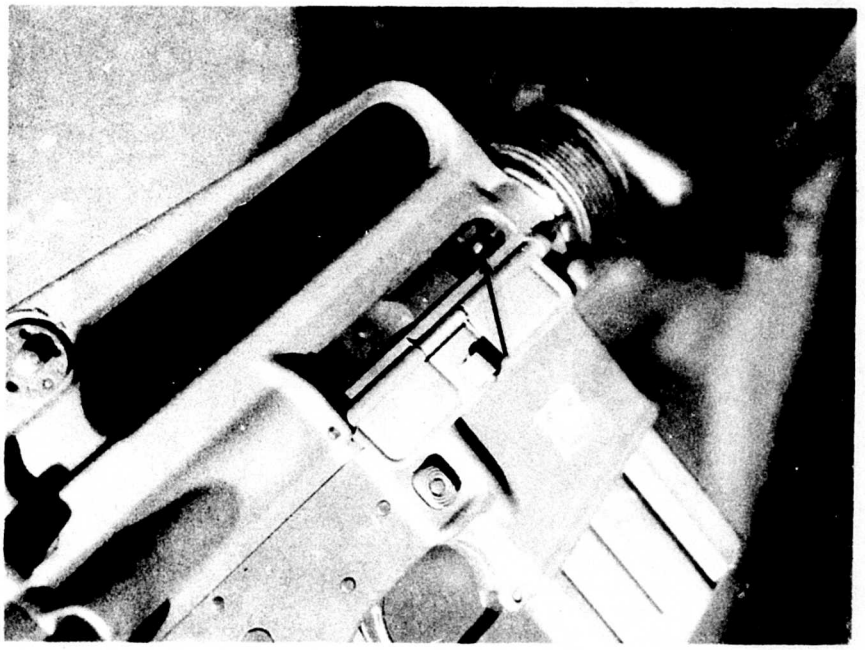


Figure 6. Rear view of same condition described in Figure 5.

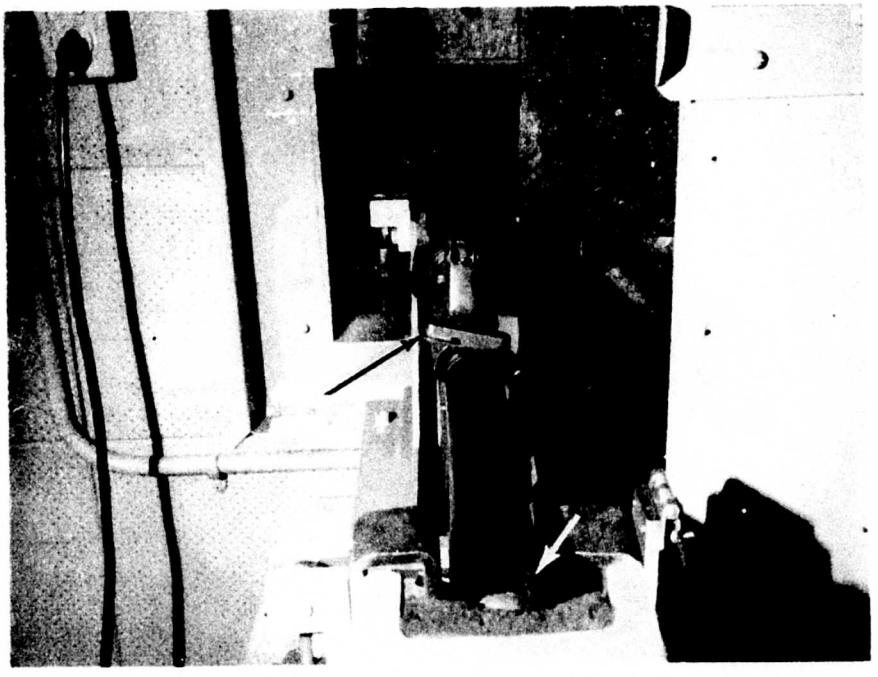


Figure 7. Rear view of damaged Fort Huachuca Rifle (Serial No. 598656) showing cracked rifle stock and twisted charging handle.

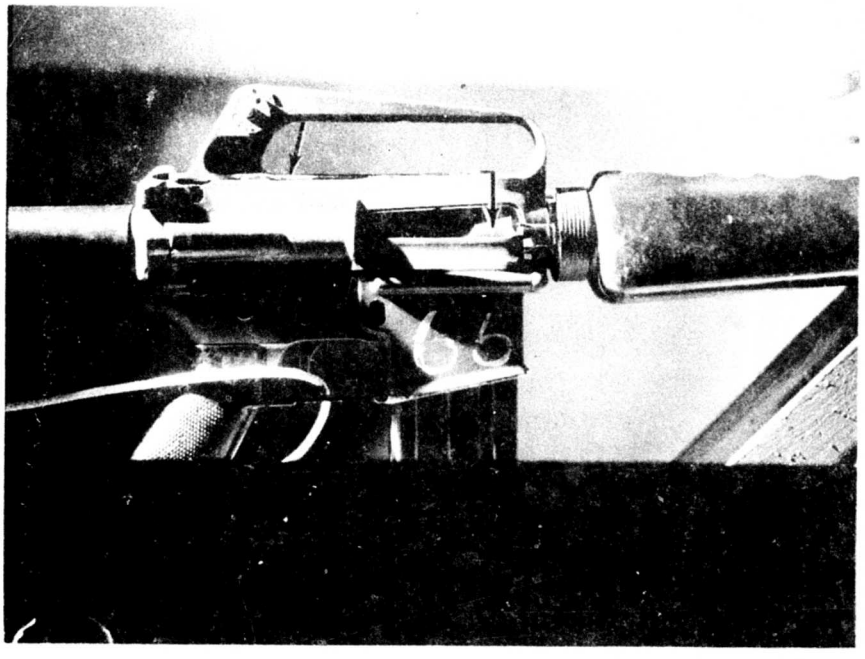


Figure 8. Side view of damaged Fort Huachuca Rifle (Serial No. 598656) showing cracked upper receiver housing.

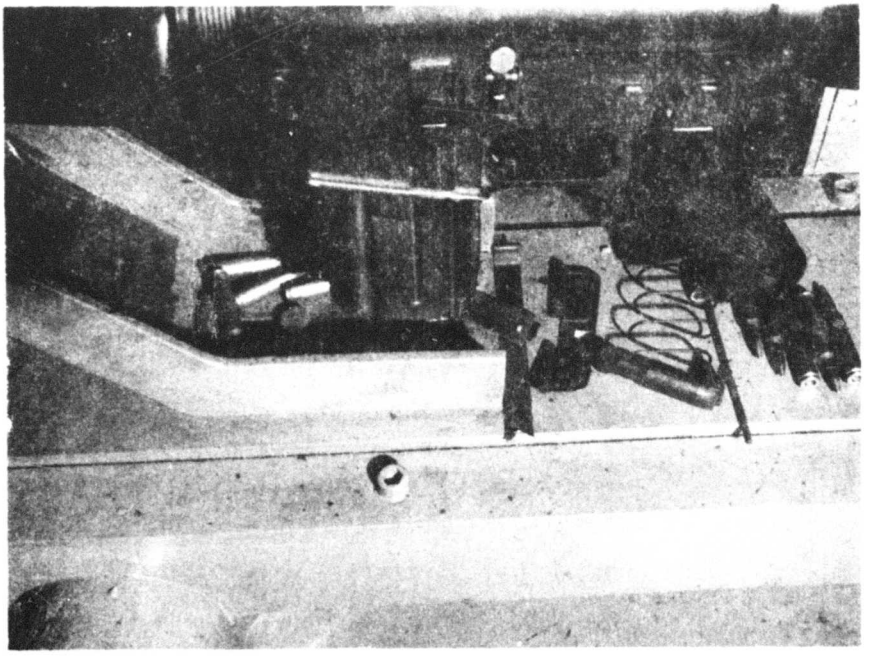


Figure 9. Side view of lower receiver showing auxiliary parts of damaged magazine, cartridges, dust cover and dust cover pin.

Figure 10. Top view showing fractured upper receiver housing and cracked carrying handle.

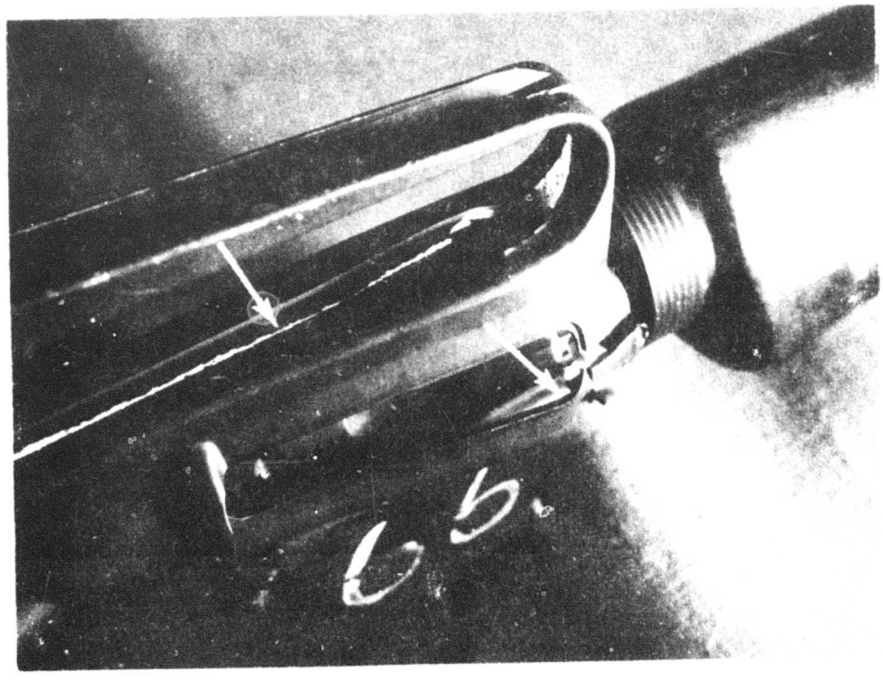


Figure 11. Side view showing fractured upper receiver housing, cracked carrying handle and closed bolt.

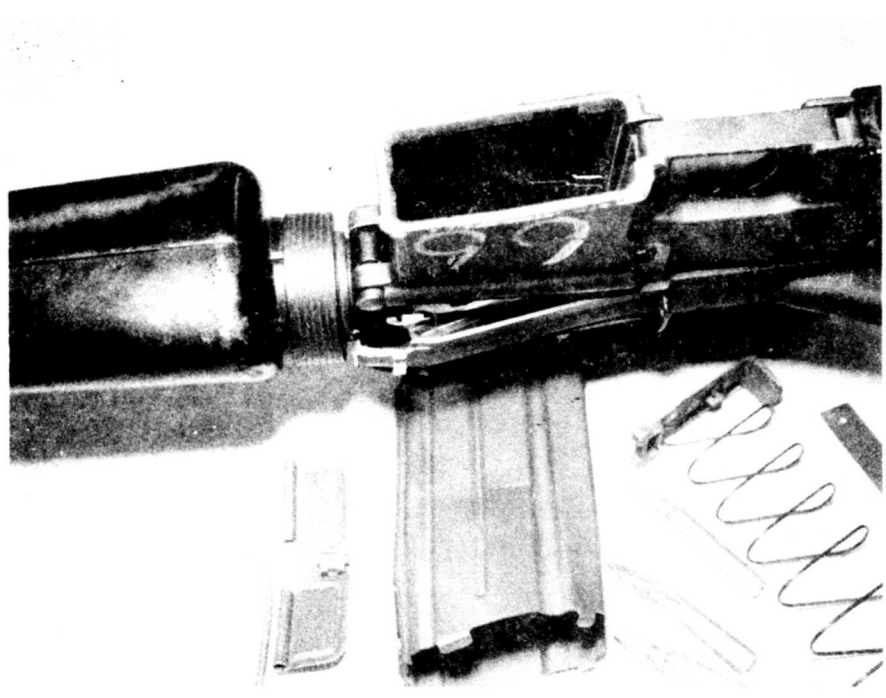


Figure 12. Bottom view showing bulged magazine housing, damaged magazine and auxiliary parts.

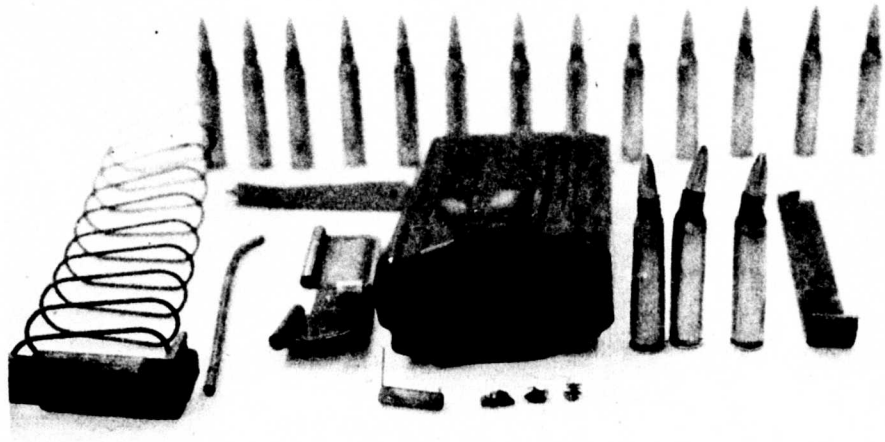


Figure 13. View showing recovered magazine, auxiliary parts and cartridges. Note three damaged cartridges.

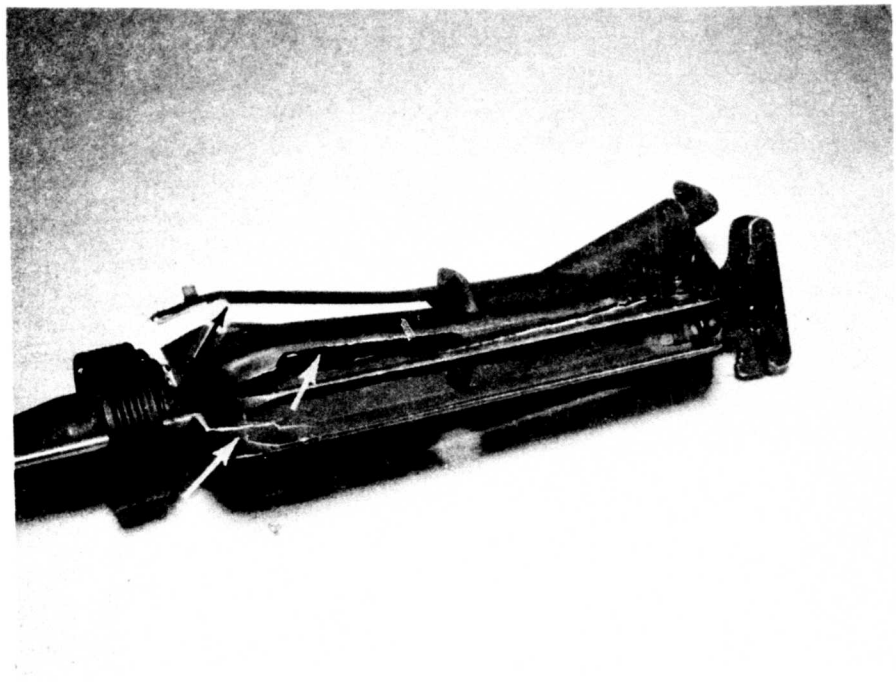


Figure 14. Top view showing fractured upper receiver housing.

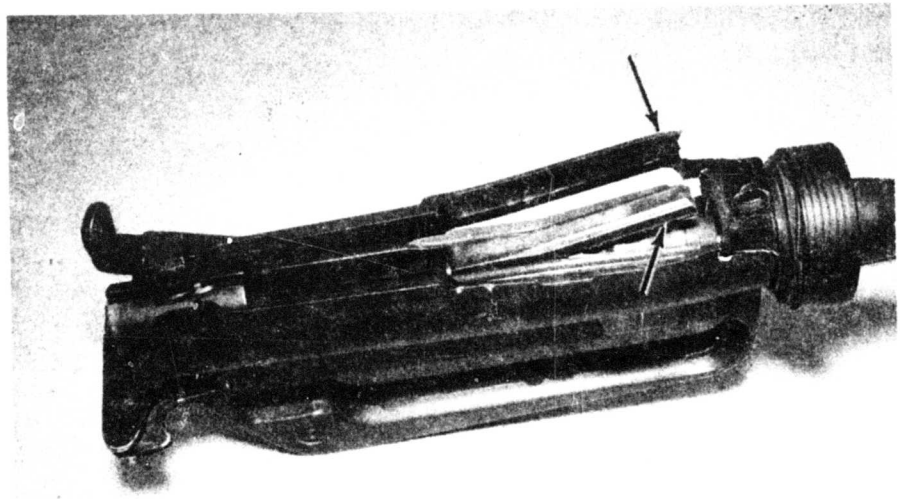


Figure 15. View showing fractured upper receiver housing and bolt carrier.

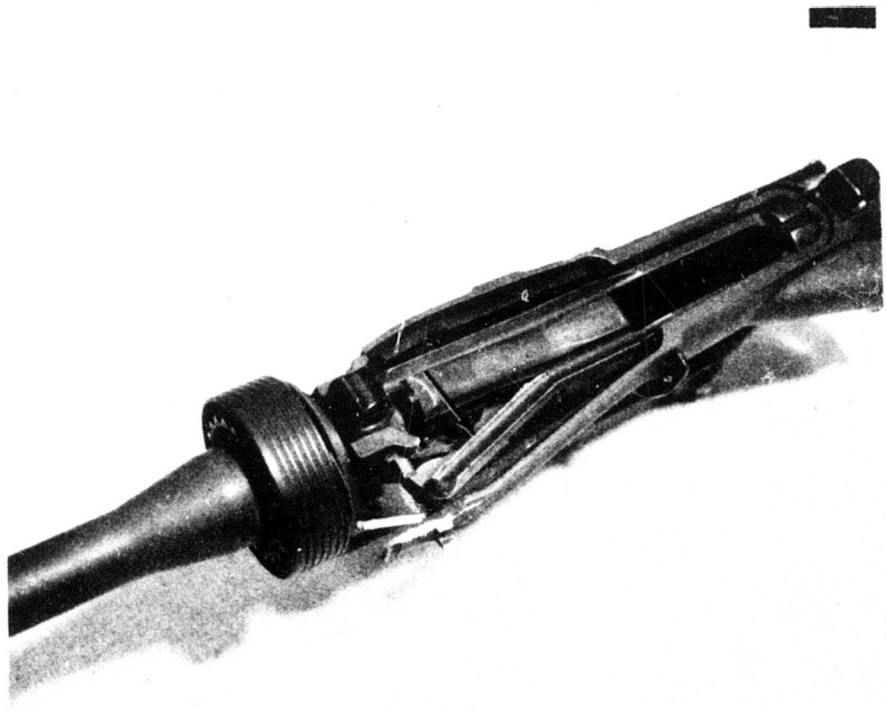


Figure 16. Bottom view of same condition described in Figure 15.

Figure 17. View showing undamaged bolt and bent extractor.

Figure 18. View showing fractured bolt carrier.

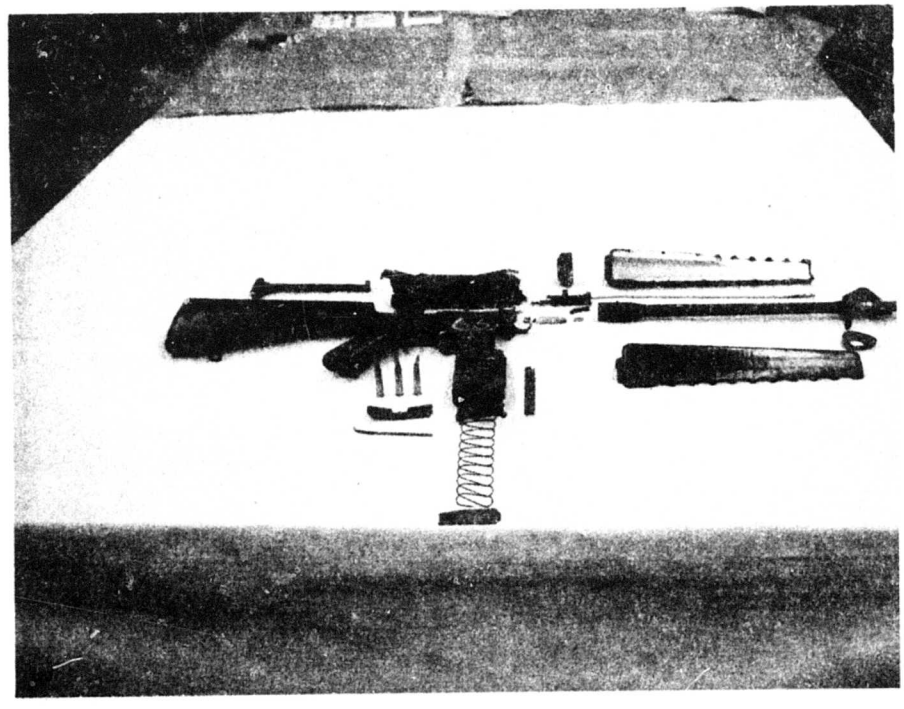


Figure 19. View showing disassembled parts of damaged weapon.

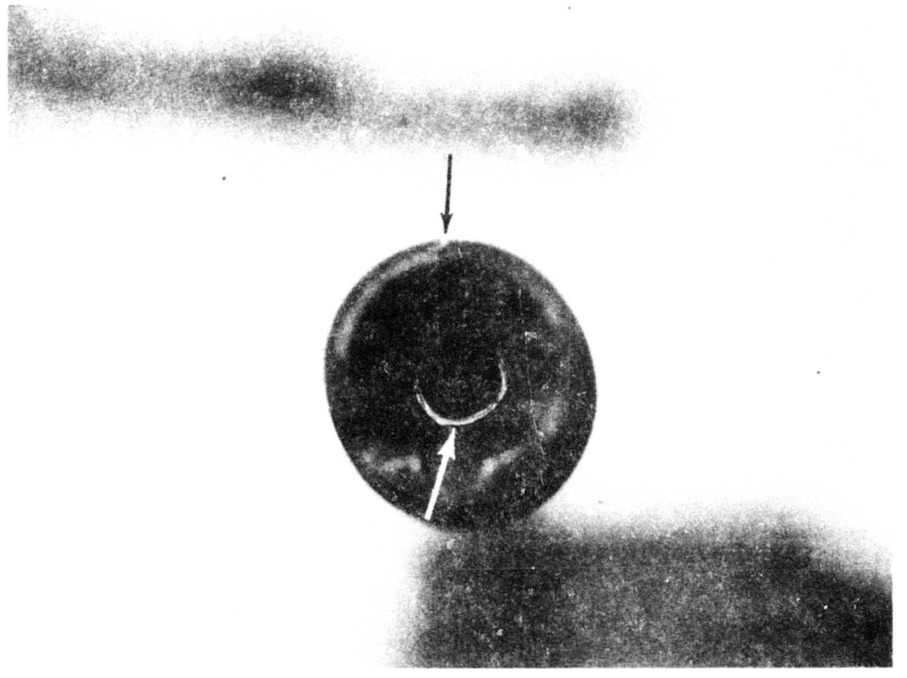


Figure 20. View showing crack in wall of barrel extending through locking lugs and body of a cartridge case. (Case head was sheared off during weapon disassembly.)

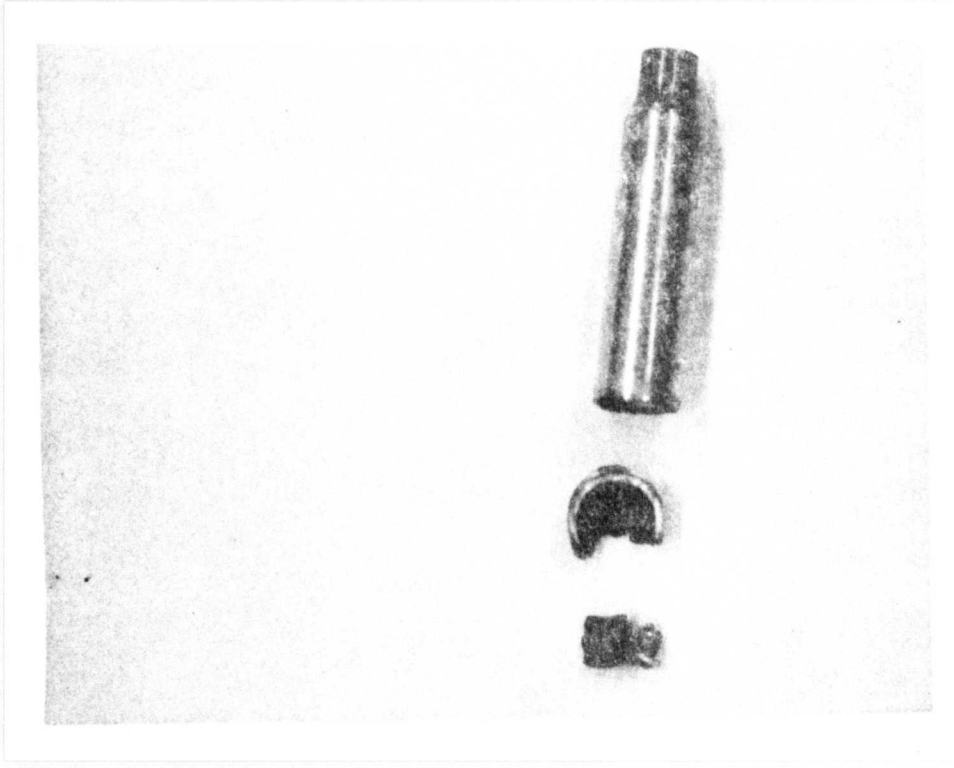


Figure 21. View showing body of cartridge case after removal from the chamber. The smaller portion of the case head was pulled off by the extractor when the weapon was fired.

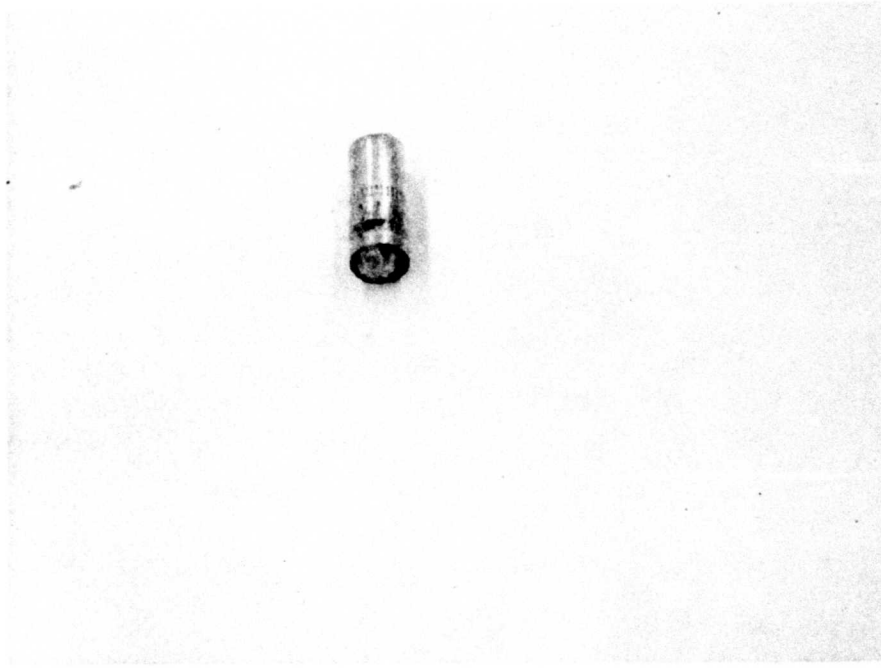


Figure 22. View of partial bullet jacket removed from bullet seat.

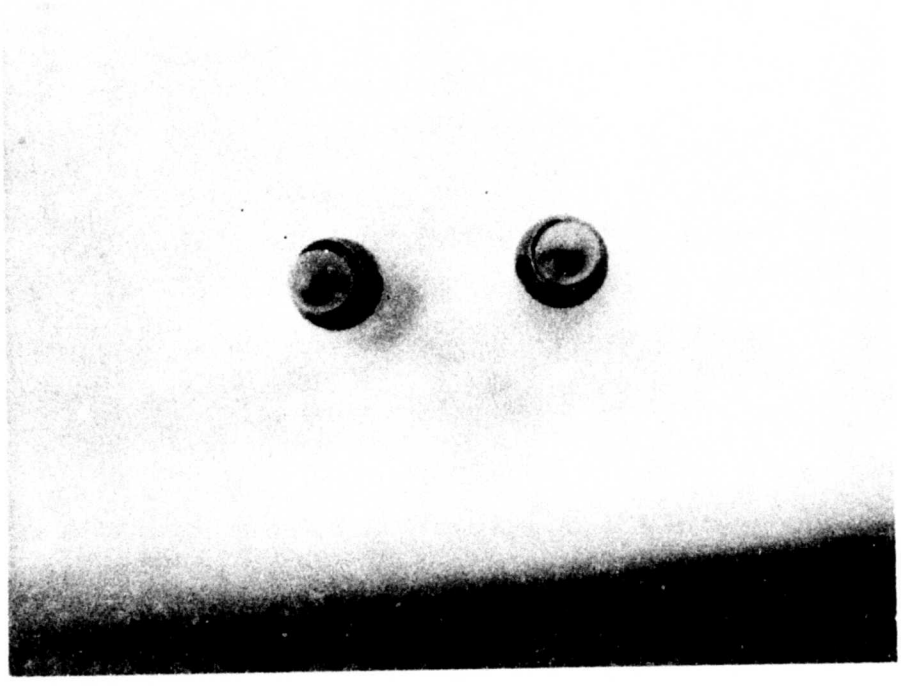


Figure 23. View showing two uncrimped cartridges.

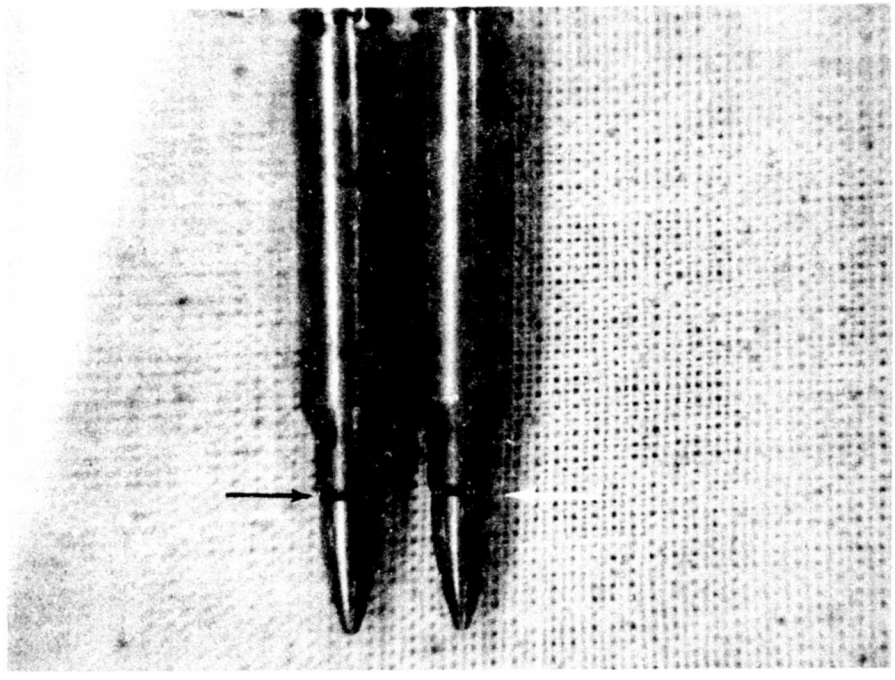


Figure 24. View showing two modified cartridges after extraction. An observation of the cannelures shows one cartridge which elongated upon firing and a second cartridge which did not elongate upon firing.

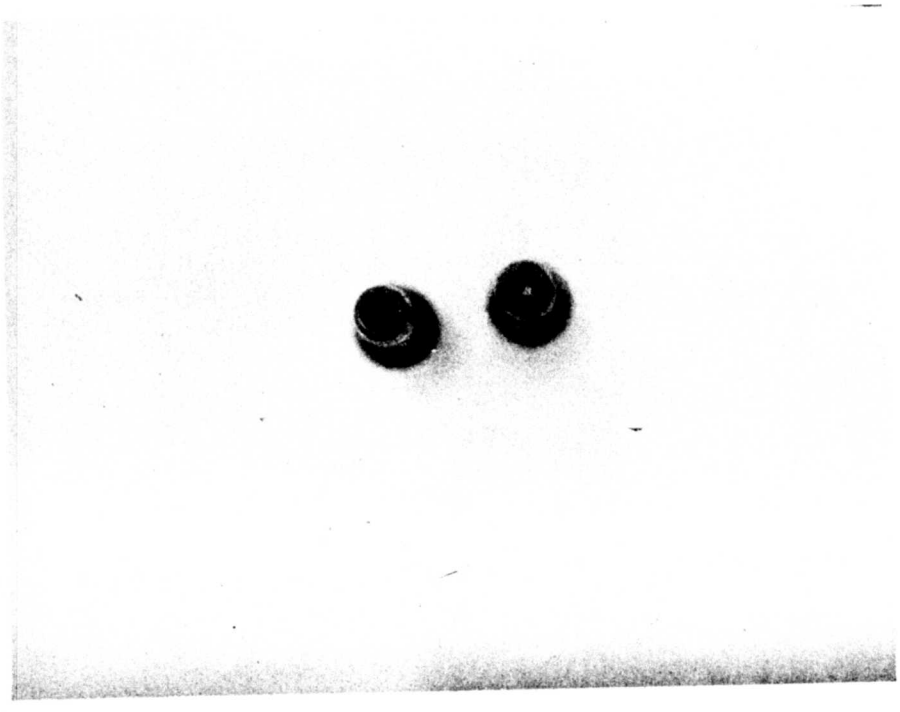


Figure 25. View showing two bullets after removal from the bore of the weapon. One shows no indentation at the base while the other shows an indentation made in attempting to chamber the succeeding round.

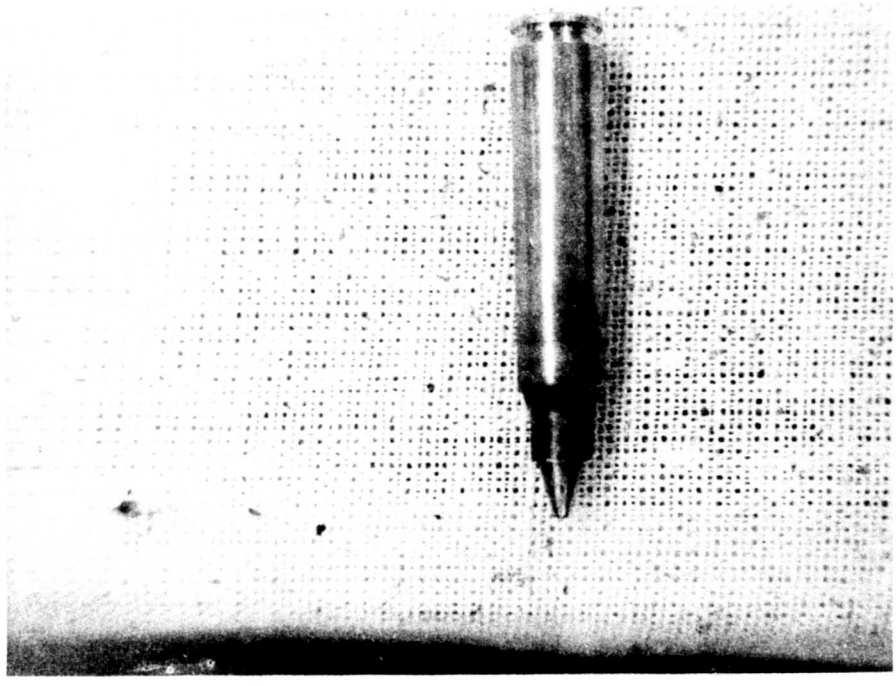


Figure 26. View showing the telescoping of an unmodified cartridge from an attempt to chamber it behind a bullet in the bore of the weapon.

APPENDIX A

TEST PROGRAM REQUEST

TO: Engr Proof Testing Lab, J9200			**DATE:** 8 May 1969
FROM: Propellant & Pyrotechnics Lab, J9300			
SUBJECT: Bullet in Bore Study			**PROJECT ENGINEER:** F. Braun/R. Fedyna, x24132
TPR #: J9300-8-69	**PROJECT AUTHORITY:** SEA-02	**AMC-CMS CODE #:**	**EXPENDITURE ORDER:** XO 93906-24

1. TYPE OF TEST and TEST OBJECTIVE:

See attached sheet.

2. MATERIEL FOR TEST:

Two ammo boxes each containing 840, 5.56mm, Ball, M193 cartridges - Lots LC12507 and TW18310.

3. BRIEF BACKGROUND AND SYNOPSIS OF PRESENT SITUATION:

It has been determined that a number of M16A1 rifles being used at training installations were "Blown Up" due to the lodging of a bullet in the bore. The purpose of this test is to duplicate some of the conditions encountered during the investigations.

4. FACILITIES REQUIRED AND DESIRED TEST SITE:

Bldg. 521 - Bullet Pull Machine - Inertia Pull Machine - Range to fire tests.

5. PRECAUTIONS IN HANDLING AND TESTING:

Observe normal safety precautions.

6. RECOMMENDED TEST PROGRAM:

See attached sheet.

7. TYPE REPORT DESIRED:

See attached sheet.

8. DATE MATERIEL AVAILABLE FOR TEST:	**DESIRED DATE OF COMPLETION OF TEST:**

9. COORDINATION: *(IF ADDITIONAL SPACE IS REQUIRED CONTINUE ON BLANK PAPER)*

See attached sheet.

SMUFA Form 1109, 13 Dec 66 (Formerly SMUFA Form 3742)

1. TYPE OF TEST AND TEST OBJECTIVE:

a. To test and record the bullet pull values of 5.56mm cartridges as received - Lots LC 12507 and TW 18310 - in order to verify bullet pull is 100^{+} lbs.

b. Inertia pull 5.56mm cartridges - Lots LC 12507 and TW 18310 - to save bullets and cases and scrap the propellant.

c. After reassembly, test and record in order to verify two (2) bullet pull values - 35-50 lbs. and 100^{+} lbs.

6. RECOMMENDED TEST PROGRAM:

a. Verification of bullet pull values of 5.56mm cartridges as given on the Acceptance Sheets.

LC 12507	TW 18310
20 Rds	20 Rds

b. Inertia pull, 200 from each lot - LC 12507 and TW 18310 - Scrap propellant and save all cases and bullets separately.

LC 12507		TW 18310	
200 Rds		200 Rds	
200 Cases	200 Bullets	200 Cases	200 Bullets

c. Reassemble bullets in cases without propellant to obtain two (2) bullet pull values for each lot - LC 12507 and TW 18310. After obtaining these values, record pull of 20 rd each.

LC 12507		TW 18310	
35-50 lbs	100^{+} lbs	35-50 lbs	100^{+} lbs
20 rds	20 rds	20 rds	20 rds

7. TYPE REPORT DESIRED:

Record all bullet pull values of the original cartridges. After establishing bullet pulls of 35-50 lbs and 100^{+} lbs, record the values. Record all firing tests as recommended on attached sheets.

9. COORDINATION:

It is requested that Project Engineers, F. Braun and R. Fedyna, x24132, 21130, be present during all bullet pullings and test firings so that detailed instructions may be given. It is also requested that an advance notice of no less than 5 working days be given so that a WECOM representative may be present to witness the firing tests.

SUGGESTED TEST PLAN FOR BULLET IN BORE STUDY

A. MATERIAL REQUIRED:

1. Rifles:

(a) One new M16A1 Rifle. **

(b) One M16A1 Rifle with approximately a 10,000 round history. **

(c) One M16A1 Rifle with approximately a 20,000 round history. *

2. Ammunition:

(a) 300 rounds of 5.56mm, M193 with Federal 195 primers - Sample I (TW 18310).

(b) 300 rounds of 5.56mm, M193 with No. 41 primers - Sample II (LC 12507).

* To be supplied by AMCPM-RS

** To be supplied by Frankford Arsenal

B. PROCEDURE:

1. Obtain chamber casts and air-gage readings of test barrels.

2. Visually inspect chamber and bore of test barrels.

3. Modify 15 rounds of each ammunition sample as follows:

(a) De-bullet rounds using an inertia bullet puller, dump the propellant, reassemble the bullet and case and crimp. Check bullet pull of 20 rounds from the original sample and affirm that cartridges have approximately the same bullet pull after reassembly and crimping (approximately 100 pounds).

(b) Repeat (a) except for bullet pull of approximately 35 pounds.

(c) De-bullet rounds by pressing the bullet meplat on a hard surface, dump the propellant and reassemble without crimping.

4. Perform the following tests with the crimped and uncrimped modified cartridges of samples I and II in each of the three test rifles.

(a) Load a twenty round magazine with 19 rounds of ammunition from the unmodified sample and one modified round. The modified round is to be loaded as the third round to be fired.

(b) Insert the magazine into the weapon and fire full automatic.

(c) When the malfunction occurs with the modified round pull the charging handle to the rear, eject the round and engage the bolt catch.

(d) If the bullet remains in the chamber release the bolt catch in an attempt to chamber the next round.

(e) If the round fails to chamber employ the bolt assist.

(f) If the round will still not chamber eject the round and repeat steps (d) and (e) with the next two rounds.

(g) Repeat steps (a) through (f) with four additional modified rounds.

(h) Measure the overall length of all modified rounds in which the bullet stays in the case after firing.

Do not fire any rounds which chamber after firing the modified rounds. Obtain photographs of all test conditions and significant results.

5. After completion of step #4, conduct the following test using the Huachuca rifle. Seat a bullet into the rifling far enough to allow for the chambering of a live round. Fire the live round and make note of the result and obtain photographs.

This test plan is subject to modification as results develop.

APPENDIX B

(10-7-68)

LC 3442 (Rev 7-10-68)

DATE PRESENTED 10/29/68
QUANTITY PACKED 2,094,960
FSN 1305-926-3930-(A071)

FUNCTIONAL LOT NOS.

AMCMS CODE
4610.16.0229.2.05.FY68

SPEC NO MIL-C-99630 REV A/4
ECO DATE 2-16-68
DAG NO D-10523632
REV E DATE 8-11-66

REMINGTON ARMS COMPANY INC
Lake City Army Ammunition Plant

INSPECTION REPORT – 5.56MM

ITEM Ctg., Ball, M193

LOT NO LC- 12507

ACCEPTED XX 1st TEST XX

REJECTED ☐ RETEST ☐

WAIVER ☐

ACCEPTANCE DATE 8 November 1968

CONTRACTOR: Remington Arms Co., Inc.
CONTRACT NO. DA-49-010-AMC-3(A)
PRIMER NO. 41 MIX FA 956
PRIMER LOT NOS. 10-471,473,474,47
PROPELLANT TYPE WC 846
A.L. NO. 45609 - 45611
CHG (GRS) 27.6
CASE- STEEL BRASS XX
HEADSTAMP (YR) LC 68
BULLET JACKET Gilding Metal

FIRING TESTS	RDS FIRED	RECORD	SPEC LIMITS
VELOCITY (FPS)	20	3253	3250±40
Corrected Avg (Amb)	XXXX	21.0	40 Max.
Standard Deviation	10	+42	(-250
125°	10	-15	(From
160° Reduced to 70°	20	-77	(Avg.
65°			
CHAMBER PRESSURE (PSI)	20	47700	52000 Max
Corrected Avg. (Amb)	XXXX	52400	58000
Avg. 3σ (Amb)	10	+865	(+5000
125°	10	+1455	(From
160° Reduced to 70°	20	-1755	(Avg.
-65°			
PORT PRESSURE	20	15300	15000 ±2000
Corrected Avg (Amb)	10	-20	(±2000
125°	10	-370	(From
160° Reduced to 70°	20	-525	(Avg.
-65°			
ACCURACY (Inch) @200 Yds.	90	1.3	2.0 Max.
Mean Radii			
ACTION TIME(MS)	50	1.16	4.0 Max.
TRACE @500 Yds.	100		Min.
No. Tracing	XXXX		
No. Bullet Bursts	XXXXX		
No. Erratic Flights	XXXX		
No Muzzle Flashes			

FIRING TESTS

FUNCTION

RDS. FIRED	Amb.	125° ± 2°	160° - 2° REDUCED 70° to ± 2°	-65° ± 2°	RECORD	SPEC LIMIT
RIFLE	120	60	60	120	OK	
RIFLE	120	60	60	120	OK	

CASUALTIES None

NON FIRING TESTS	No. Tested	Record	Spec. Limit
CARTRIDGE Waterproof(Vac)	50	0	3
BULLET Extraction(Lbs) Record: Mean 84 Max. 109	25	Min. 70	Min. 35
Base Closure Seal			
CASE Residual Stress (Mercurous Nitrate) Record:	50	0	0

TOTAL Authorized Rds. Expended in Tests *2115

Lot inspected in accordance with contract requirements (Except as otherwise authorized and noted hereon).

REMARKS: *1000 rounds expended in Ballistics in accordance with 1050 Message AM-LC-14-67, dated 12/5/67 - Fouling Test.

Diamond Pyramid Hardness Test -- OK

Date Presented 3 APRIL 1968
Quantity Packed 3,017,280 rds *
FSN 1305-926-3930-A071

Functional Lot Nos.

AMCMS Code 4810.16.0229.2.04

Spec. No. MIL-C-9963D Rev. A/4
ECO Date
Dwg. No. D10523632
Rev. D Date 2-17-65

TWIN CITIES ARMY AMMUNITION PLANT
INSPECTION REPORT – 5.56MM

ITEM CTGS 5.56 MM BALL M855

Lot No. TW- 18310

Accepted [X] 1st Test [X]
Rejected [ ] Retest [ ]
Waiver [ ]

Acceptance Date 12 APRIL 1968

Contractor Federal Cartridge Corp.
Contract No. DA-36-038-AMC-1099(A)
Primer No. DA-36-038-AMC-1099(A) 195
Primer Lot Nos. 387A · 388A · 389A 386A
Tracer Mix
Igniter Mix
Propellant Type WC 846 ✓
A.L. No. 44978 - 45481
Chg. (Grs) 27.9 28.3 28.4
Case - Steel [ ] Brass [X]
Headstamp (Yr) 1968
Bullet Jacket

FIRING TESTS

CHAMBER PRESSURE (PSI)	AMB	125°	160°	-65°
RDS FIRED	20	10	10	20
RECORD	49,400	+1000	-1500	-5300
LIMIT - MAX	52,000	+ 5,000	+ 5,000	+ 5,000
AVG + 3 SD	55,800			
LIMIT - MAX	58,000			
PORT PRESSURE (PSI)				
RECORD	15,500	-220	+480	-50
LIMIT	15,000 ± 2,000	+-2,000	+-2,000	+-2,000
VELOCITY @ 15 FT. (FS)				
RDS FIRED	20	10	10	20
RECORD	3234	+44	-53	-213
LIMIT - BALL	3250 ± 40	-250	-250	-250
LIMIT - TRACER	3200 ± 40	-250	-250	-250
STD DEV	19.6			
LIMIT	40			

ACCURACY (INCHES)	RDS FIRED	RECORD	LIMIT
MEAN RADII @ 200 YDS	90	.8	5.0 2.0
ACTION TIME (MS)	50	1.66	4.0

FUNCTION & CASUALTY	RDS FIRED	RECORD	LIMIT
RIFLE, 5.56MM, XM16E1	720		
CASUALTIES		NONE	

TRACE PERFORMANCE	NO. RDS.	RECORD	LIMIT
% TRACING @ 500 YDS.	100		80%
NO. TOTAL BLINDS			
NO. SHORT TRACE			
NO. LATE TRACE			

WATERPROOF TEST

NO. TESTED	NO. FAILED	SPEC. LIMIT
50	0	3

DESCRIPTION OF DEFECTS

BULLET EXTRACTION TEST (Lbs.)

No. Tested	SPEC. MIN.	NO. FAILED	MAX.	MIN.	MEAN
25	35	0	116	52	82

MERCUROUS NITRATE TEST

NO TESTED	NO. FAILED	SPEC. LIMIT
50	0	0

BASE CLOSURE SEAL TEST

NO. TESTED	NO. FAILED	SPEC. LIMIT
		3

VISUAL GAGE & WEIGH INSPECTION

1st SAMPLE 2400 DATE 4-3-68
2nd SAMPLE

	CRITICAL	MAJOR	MINOR
AQL %	.04	.25	1.50
NO DEFECTIVE		0	1
DEFECT NO. & DESCRIPTION			1131
TOTAL		0	1

PACKING INSPECTION - CONTAINER CONTENT

SUB-LOT	MAJOR % DEFECTIVE	MAJOR AQL %	MINOR % DEFECTIVE	MINOR AQL %
		1.0		2.5
1ST	0		M 1	
2ND	0		0	

TOTAL AUTHORIZED RDS EXPENDED IN TESTS: (1040)

REMARKS: TEN ADDITIONAL ROUNDS TESTED FOR CASE HARDNESS (INFORMATION ONLY) AS PER SMUAP-AMM DATED 12-5-67.

* IN ADDITION, 1000 ROUNDS (1 CRATE) SHIPPED TO LAKE CITY ARMY AMMUNITION PLANT FOR FOULING TEST.

O Anderson
CHIEF BALLISTICIAN TCAAP

12 APR 68
CHIEF, GOVERNMENT QA DIVISION

SMUTC.Q FORM 5
25 APR. 67

REPLACES SMUTC FORM 116 WHICH IS OBSOLETE

APPENDIX C

BULLET PULL VALUES OF CARTRIDGES AS RECEIVED

	TW 18310	LC 12507
1	92 pounds	90 pounds
2	106 pounds	98 pounds
3	86 pounds	78 pounds -
4	92 pounds	92 pounds
5	108 pounds	110 pounds
6	102 pounds	114 pounds +
	114 pounds	110 pounds
8	102 pounds	80 pounds
9	112 pounds	92 pounds
10	118 pounds +	82 pounds
11	86 pounds	108 pounds
12	96 pounds	92 pounds
13	92 pounds	94 pounds
14	100 pounds	96 pounds
15	110 pounds	88 pounds
16	88 pounds	108 pounds
17	98 pounds	94 pounds
18	88 pounds	102 pounds
19	78 pounds -	96 pounds
20	96 pounds	84 pounds
Average	98.2 pounds	95.4 pounds

APPENDIX D

BULLET PULL VALUES (35-50 POUNDS)

RECRIMPED CARTRIDGES

	TW 18310	LC 12507
1	34 pounds	39 pounds
2	23 pounds	17 pounds -
3	39 pounds	42 pounds
4	27 pounds	29 pounds
5	42 pounds	57 pounds +
6	36 pounds	25 pounds
7	43 pounds	47 pounds
8	35 pounds	38 pounds
9	28 pounds	36 pounds
10	21 pounds -	25 pounds
11	45 pounds	35 pounds
12	50 pounds	23 pounds
13	50 pounds	49 pounds
14	52 pounds +	30 pounds
15	33 pounds	54 pounds
16	29 pounds	24 pounds
17	35 pounds	55 pounds
18	34 pounds	28 pounds
19	31 pounds	37 pounds
20	46 pounds	42 pounds
Average	36.65 pounds	36.60 pounds

BULLET PULL VALUES (100 ± POUNDS)

RECRIMPED CARTRIDGES

	TW 18310	LC 12507
1	114 pounds	100 pounds
2	110 pounds	94 pounds
3	80 pounds	120 pounds
4	92 pounds	97 pounds
5	114 pounds	96 pounds
6	122 pounds	76 pounds
7	120 pounds	92 pounds
8	82 pounds	80 pounds
9	122 pounds	108 pounds
10	76 pounds -	126 pounds +
11	94 pounds	94 pounds
12	96 pounds	84 pounds
13	150 pounds +	96 pounds
14	91 pounds	96 pounds
15	88 pounds	80 pounds
16	96 pounds	97 pounds
17	100 pounds	78 pounds
18	106 pounds	120 pounds
19	88 pounds	84 pounds
20	90 pounds	74 pounds -
Average	101.55 pounds	94.60 pounds

APPENDIX E

BORE GAGING RECORD

DATE: 17 JUNE

CAL. 5.56 mm MODEL: M-16 SERIAL NO: 598656

HUACHUCA WEAPON USED IN TEST

DISTANCE MUZZLE INCHES	LAND DIAMETER INCHES VERTICAL	LAND DIAMETER INCHES HORIZONTAL	GROOVE DIAMETER INCHES VERTICAL	GROOVE DIAMETER INCHES HORIZONTAL
~~0.5~~	.2203"		.2245"	
1	.2203"			
2	.2202"			
3				
4	.2202"			
5	.2201"		.2245"	
6	.2203"		.2244"	
7	.2201"		.2244"	
8	.2199"		.2242"	
9	.2199"			
10	.2198"			
11	.2198"			
12	.2197"		.2242"	
13	.2200"		.2243"	
14	.2202"		.2241"	
15	.2203"		.2241"	
16	.2210"		.2243"	
17	OVER MAX		.2246"	
~~18~~ 17.5"	CALIBRATION		OVER MAX	
19				
20				
21				
22				
23	HEAD SPACE = 1.505			
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
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40				
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43				
44				
45				

SMUFA-J Form 23, 26 Sep 67
(Formerly SMUFA-U Form 12)

BORE GAGING RECORD

DATE: 17 JUNE

CAL. 5.56 mm MODEL: M-16. SERIAL NO: 866725 thru 886725

10,000 RD. WEAPON

DISTANCE MUZZLE INCHES	LAND DIAMETER INCHES VERTICAL	LAND DIAMETER INCHES HORIZONTAL	GROOVE DIAMETER INCHES VERTICAL	GROOVE DIAMETER INCHES HORIZONTAL
~~0~~ 3"	.2201"		.2244"	
1	.2201"		.2244"	
2	.2200"		.2243"	
3	.2200"			
4	.2194"		.2243"	
5	.2199"		.2242"	
6	.2198"			
7	.2198"		.2242"	
8	.2199"		.2243"	
9	.2199"			
10	.2198"			
11	.2198"			
12	.2197"			
13	.2196"			
14	.2193		.2243"	
15	.2202"		.2244"	
16	.2204"		.2244"	
17	.2208"		.2246"	
~~18~~ 17.5"	OVER MAX		.2250"	
19				
20				
21				
22				
23	HEAD SPACE = 1.494			
24				
25				
26				
27				
28				
29				
30				
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SMUFA-J Form 23, 26 Sep 67
(Formerly SMUFA-U Form 12)

BORE GAGING RECORD

DATE: 17 JUN..

CAL. 5.56 m m MODEL: M-16 SERIAL NO: 1326633

NEW WEAPON

DISTANCE MUZZLE INCHES	LAND DIAMETER INCHES VERTICAL	LAND DIAMETER INCHES HORIZONTAL	GROOVE DIAMETER INCHES VERTICAL	GROOVE DIAMETER INCHES HORIZONTAL
.5	.2197"		.2242"	
1	.2196"		.2240"	
2			.2239"	
3				
4				
5				
6	.2196"		.2239"	
7	.2197"		.2235"	
8	.2195"			
9	.2196"			
10	.2197"			
11	.2196"		.2235"	
12	.2195"		.2239"	
13	.2197"			
14				
15			.2239"	
16			.2238"	
17	.2197"		.2238"	
17.5	.2198"		.2239"	
19				
20				
21				
22				
23	HEAD SPACE = 1.511			
24				
25				
26				
27				
28				
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SMUFA-J Form 23, 26 Sep 67
(Formerly SMUFA-U Form 12)

BORE GAGING RECORD

DATE: 17 JUNE

CAL. 5.56 mm MODEL: M-16 SERIAL NO: 605730

HUACHUCA WEAPON (A)

DISTANCE MUZZLE INCHES	LAND DIAMETER INCHES VERTICAL	LAND DIAMETER INCHES HORIZONTAL	GROOVE DIAMETER INCHES VERTICAL	GROOVE DIAMETER INCHES HORIZONTAL
~~0~~, 5"	.2203"		.2243"	
1	.2203"		.2243"	
2	.2202"		.2242"	
3	.2201"		.2241"	
4	.2201"		|	
5	.2200"		|	
6	.2200"		.2241"	
7	.2201"		.2240"	
8	.2200"		|	
9	|		|	
10	.2200"		|	
11	.2201"		|	
12	.2202"		|	
13	.2203"		|	
14	.2204"		|	
15	.2204"		|	
16	OVER MAX		.2240"	
17	CALIBERATION		.2243"	
~~18~~ 17.5"			.2249"	
19				
20				
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SMUFA-J Form 23, 26 Sep 67
(Formerly SMUFA-U Form 12)

BORE GAGING RECORD

DATE: 17 JUNE

CAL. 5.56 mm MODEL: M-16 SERIAL NO: 602794

HUACHUCA WEAPON (3)

DISTANCE MUZZLE INCHES	LAND DIAMETER INCHES		GROOVE DIAMETER INCHES	
	VERTICAL	HORIZONTAL	VERTICAL	HORIZONTAL
0.5	.2201"		.2241"	
1	.2200"		.2240"	
2	.2201"			
3	.2200"			
4			.2240"	
5	.2200"		.2239"	
6	.2199"			
7	.2200"			
8	.2199"			
9	.2199"			
10	.2198"		.2239"	
11	.2196"		.2238"	
12	.2195"			
13	.2195"			
14	.2196"			
15	.2196"		.2238"	
16	.2201"		.2239"	
17	OVER MAX		.2244"	
17.5	CALIBRATION		.2244"	
19				
20				
21				
22				
23				
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(Formerly SMUFA-U Form 12)

APPENDIX F

SUMMARY OF TEST RESULTS

HUACHUCA RIFLE (SERIAL NO. 598656)

Crimp Type	Magazine	LC 12507 (No. 41 Primer)				TW 18310 (No. 195 Primer)			
		Bullet in Bore	Bullet Location *	Base Indent By Next Round	Complete Chambering of Two Succeeding Rounds	Bullet in Bore	Bullet Location *	Base Indent By Next Round	Complete Chambering of Two Succeeding Rounds
None	1	Failure to Feed		--	---	Yes	16.750	No	Yes
	2	Yes	16.437	No	Yes	Yes	16.688	No	Yes
	3	Yes	16.625	No	Yes	Yes	16.750	No	Yes
	4	Yes	16.625	No	Yes	Yes	16.688	No	Yes
	5	Failure to Feed		--	---	Yes	16.750	No	Yes
Light (35 Pounds)	1	Yes	16.750	No	Yes	Yes	16.688	No	Yes
	2	Yes	16.625	No	Yes	Yes	16.750	No	Yes
	3	Yes	16.625	No	Yes	Yes	16.688	No	Yes
	4	Yes	16.437	No	Yes	Yes	16.750	No	Yes
	5	Yes	16.562	No	Yes	Yes	16.750	No	Yes
Heavy (100 Pounds)	1	No	---	--	---	No	---	--	---
	2	No	---	--	---	No	---	--	---
	3	No	---	--	---	No	---	--	---
	4	Yes	16.594	No	Yes	No	---	--	---
	5	No	---	--	---	No	---	--	---
	6	Yes	16.625	No	Yes	No	---	--	---
	7	No	---	--	---	No	---	--	---
	8	No	---	--	---	No	---	--	---
	9	No	---	--	---	No	---	--	---
	10	Yes	16.562	No	Yes	No	---	--	---
	11	Yes	16.688	No	Yes	No	---	--	---
	12	No	---	--	---	No	---	--	---
	13	Yes	16.750	No	Yes	No	---	--	---
	14	No	---	--	---	No	---	--	---
	15	No	---	--	---	No	---	--	---
	16	No	---	--	---	No	---	--	---
	17	No	---	--	---	No	---	--	---
	18	No	---	--	---	No	---	--	---
	19	No	---	--	---	No	---	--	---
	20	No	16.625	No	Yes	No	---	--	---

* Bullet location measured from muzzle of rifle (without flash suppressor) to meplat of lodged bullet (inches).

APPENDIX G

SUMMARY OF TEST RESULTS

10,000-ROUND RIFLE (SERIAL NO. 866725)

Crimp Type	Magazine	LC 12507 (No. 41 Primer)				TW 18310 (No. 195 Primer)			
		Bullet in Bore	Bullet Location *	Base Indent By Next Round	Complete Chambering of Two Succeeding Rounds	Bullet in Bore	Bullet Location *	Base Indent By Next Round	Complete Chambering of Two Succeeding Rounds
None	1	Yes	17.062	Yes	Yes	Yes	17.188	Yes	No
	2	Yes	17.125	Yes	Yes	Yes	17.188	Yes	No
	3	Yes	17.188	Yes	No	Yes	17.188	Yes	No
	4	Yes	17.125	Yes	Yes	Yes	17.188	Yes	No
	5	Yes	17.188	Yes	No	Yes	17.188	Yes	No
Light (35 Pounds)	1	Yes	17.062	Yes	No	Yes	17.125	Yes	No
	2	Yes	17.062	Yes	Yes	Yes	17.125	Yes	No
	3	Yes	17.125	Yes	No	Yes	17.188	Yes	No
	4	Yes	17.000	No	Yes	Yes	17.188	Yes	No
	5	Yes	17.062	Yes	No	Yes	17.188	Yes	No
Heavy (100 Pounds)	1	Yes	17.125	Yes	Yes	No	---	---	--
	2	No	---	---	---	No	---	---	--
	3	No	---	---	---	No	---	---	--
	4	No	---	---	---	No	---	---	--
	5	No	---	---	---	No	---	---	--
	6	Yes	17.062	No	Yes	No	---	---	--
	7	Yes	17.062	Yes	Yes	No	---	---	--
	8	No	---	---	---	No	---	---	--
	9	No	---	---	---	Yes	17.188	Yes	No
	10	No	---	---	---	No	---	---	--
	11	No	---	---	---	No	---	---	--
	12	No	---	---	---	No	---	---	--
	13	No	---	---	---	No	---	---	--
	14	Yes	17.125	Yes	Yes	No	---	---	--
	15	No	---	---	---	No	---	---	--
	16	No	---	---	---	No	---	---	--
	17	Yes	17.000	No	Yes	No	---	---	--
	18	No	---	---	---	No	---	---	--
	19	No	---	---	---	No	---	---	--
	20	No	---	---	---	No	---	---	--

* Bullet location measured from muzzle of rifle (without flash suppressor) to meplat of lodged bullet (inches).

APPENDIX H

SUMMARY OF TEST RESULTS

NEW RIFLE (SERIAL NO. 1326633)

Crimp Type	Magazine	LC 12507 (No. 41 Primer)				TW 183 D (No. 193 Primer			
		Bullet in Bore	Bullet Location *	Base Indent By Next Round	Complete Chambering of Two Succeeding Rounds	Bullet in Bore	Bullet Location *	Base Indent By Next Round	Complete Chambering of Two Succeeding Rounds
None	1	Yes	17.437	Yes	No	Yes	17.562	Yes	No
	2	Yes	17.437	Yes	No	Yes	17.562	Yes	No
	3	Yes	17.437	Yes	No	Yes	17.625	Yes	No
	4	Yes	17.437	Yes	No	Yes	17.562	Yes	No
	5	Failure to Feed		---	--	Yes	17.562	Yes	No
Light (35 Pounds)	1	Yes	17.562	Yes	No	Yes	17.562	Yes	No
	2	Yes	17.562	Yes	No	Yes	17.562	Yes	No
	3	Yes	17.562	Yes	No	Yes	17.562	Yes	No
	4	Yes	17.562	Yes	No	Yes	17.562	Yes	No
	5	Yes	17.562	Yes	No	Yes	17.562	Yes	No
Heavy (100 Pounds)	1	No	---	---	--	No	---	---	--
	2	No	---	---	--	No	---	---	--
	3	Yes	17.562	Yes	No	No	---	---	--
	4	No	---	---	--	No	---	---	--
	5	No	---	---	--	No	---	---	--
	6	No	---	---	--	No	---	---	--
	7	Yes	17.562	Yes	No	No	---	---	--
	8	Yes	17.562	Yes	No	No	---	---	--
	9	Yes	17.562	Yes	No	No	---	---	--
	10	No	---	---	--	No	---	---	--
	11	No	---	---	--	No	---	---	--
	12	Yes	17.562	Yes	No	No	---	---	--
	13	No	---	---	--	No	---	---	--
	14	Yes	17.562	Yes	No	No	---	---	--
	15	No	---	---	--	No	---	---	--
	16	Yes	17.562	Yes	Yes	No	---	---	--
	17	Yes	17.562	Yes	No	No	---	---	--
	18	No	---	---	--	No	---	---	--
	19	No	---	---	--	No	---	---	--
	20	No	---	---	--	No	---	---	--

* Bullet location measured from muzzle of rifle (without flash suppressor) to meplat of lodged bullet (inches).

APPENDIX I

BORE GAGING RECORD

PRECISIONAIRE

DATE: 14 JULY 69

CAL. 5.56 MM MODEL: M16A1 SERIAL NO: 598656

GROOVE DIAMETERS

DISTANCE MUZZLE INCHES	1ST COMB [redacted] DIAMETER INCHES * 12 O'CLOCK 0° VERTICAL	2ND COMB 120° HORIZONTAL	3RD COMB [redacted] DIAMETER INCHES 240° VERTICAL	HORIZONTAL
0.5	.2245	.2245	.2247	
1	|	.2246	.2247	
2	|	.2246	.2247	
3	|	.2247	.2246	
4	|	.2245	|	
5	|	.2245	|	
6	.2245	.2245	.2246	
7	.2246	.2246	.2247	
8	.2245	.2245	.2245	
9	|	|	|	
10	|	|	|	
11	.2245	|	|	
12	.2246	|	.2245	
13	.2245	.2245	.2244	
14	.2243	.2243	.2244	
15	.2244	.2244	.2244	
16	.2246	.2247	.2246	
17	.2249	.2249	.2248	
~~18~~ 17.5 *				
19				
20				
21 16.1	.2246	.2246	.2245	
22 16.2	.2246	.2246	.2246	
23 16.3	.2246	.2248	.2246	
24 16.4	.2248	.2248	.2247	
25 16.5	.2249	.2250	.2249	
26 16.6	.2253	.2251	.2250	
27 16.7	.2253	.2252	.2252	
28 16.8	.2252	.2253	.2252	
29 16.9	.2249	.2249	.2250	
30				
31				
32				
33				
34				
35				
36	* GAGE SPINDLE ROTATES FREELY AT THIS POINT			
37	(NO DISTINCTION BETWEEN LANDS AND GROOVES)			
38				
39	BARREL DEFOULED WITH STANDARD METAL FOULING			
40	SOLUTION			
41				
42	* THE GAS PORT OF THE BARREL IS POSITIONED			
43	VERTICALLY UPWARD (0°)			
44				
45				

SMUFA-J Form 23, 26 Sep 67
(Formerly SMUFA-U Form 12)

BORE GAGING RECORD

PRECISION AIRE

DATE: 14 JULY

CAL. 5.56MM MODEL: M16A1 SERIAL NO: 598656

LAND DIAMETERS

DISTANCE MUZZLE INCHES	1ST COMB *12 O'CLOCK VERTICAL 0° LAND DIAMETER INCHES	2ND COMB 120° HORIZONTAL	3RD [redacted] COMB VERTICAL	DIAMETER INCHES 240° HORIZONTAL
0.5	2203	.2203	2204	
1	2203	2204	2204	
2	2203	2204	2204	
3	2202	2203	2203	
4	2202	2203	2203	
5	2202	2203	2204	
6	2204	2204	2205	
7	2205	2205	2205	
8	2202	2203	2204	
9	2203	2202	2203	
10	2202	2202	2202	
11	2202	2202	2202	
12	2202	2201	2202	
13	2203	2202	2203	
14	2204	2203	2204	
15	2204	2204	2205	
16	2210	2210	2210	
17	ABOVE MAX.			
17.5	CALIBRATION, 2210"			
18				
19				
20				
21	BARREL DEFOULED WITH STANDARD METAL FOULING			
22	SOLUTION			
23				
24	* THE GAS PORT OF THE BARREL IS POSITIONED			
25	VERTICALLY UPWARD (0°)			
26				
27				
28				
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SMUFA-J Form 23, 26 Sep 67
(Formerly SMUFA-U Form 12)

UNCLASSIFIED

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Bullet-in-Bore Study of 5.56mm, Ball, M193 Cartridge and M16A1 Rifle

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Test Report

5. AUTHOR(S) (First name, middle initial, last name)

Frank E. Braun, Jr.
Roman Fedyna

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Frankford Arsenal Philadelphia, Pa. 19137

13. ABSTRACT

This test consisted of the firing of cartridges crimped to 100 pound average bullet pull (normal representative production value), 35 pound average bullet pull (minimum specification requirement) and uncrimped cartridges, all reassembled without propellant from each of two 5.56mm, ball, M193 cartridge lots (LC12507 and TW18310) in each of three M16A1 Rifles with varying records of rounds fired.

The tests indicated that:

a. 5.56mm, Ball, M193 cartridges without propellant, when fired can lodge bullets sufficiently into the rifling of an M16A1 barrel to permit the chambering of the next round when the rifling of the barrel at the bullet seat is sufficiently worn or eroded.

b. Incidents of bullet-in-bore type malfunctions increase as the strength of the crimp is reduced.

c. The distance which a 5.56mm, Ball, M193 bullet travels, from the energy exerted by primer action alone, varies with the type of primer. The metallic fueled Number 41 type primer will impart more energy than the non-metallic fueled Number 195 primer.

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Malfunction						
Tampered cartridges						
Cartridges assembled without propellant						
Primer Type						
Bullet crimp strength						
Barrel condition						
Bolt assist						
Charging handle						